Revegetation of native wetland plants to restore habitat and improve *Phragmites* management in the Great Salt Lake watershed

Photo: K.M. Kettenring

Final report to Utah Division of Forestry, Fire & State Lands

Revegetation of native wetland plants to restore habitat and improve *Phragmites* management in the Great Salt Lake watershed

Principal Investigator: Karin M. Kettenring,
Graduate students: Rachel Hager, James Marty, David England

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Goals and objectives

The overall goal of this project is to prevent *Phragmites* invasions and restore wildlife habitat in the Great Salt Lake watershed by determining the most effective strategies for reestablishing native bulrush species.

The **specific objectives** of this project are to:

(1) Evaluate different methods (seeding, planting plugs and sod mats, transplanting rhizomes) for reestablishing native bulrush species in Great Salt Lake wetlands
(2) Identify individual genotypes of bulrushes that may limit *Phragmites* reinvasion
(3) Identify competitive genotype assemblages of bulrushes that may limit *Phragmites* reinvasion

Objective 1: Evaluate different methods for reestablishing native bulrush species in Great Salt Lake wetlands

Methods

We established a large-scale field experiment at the Bear River Migratory Bird Refuge in summer 2015 and monitored plots through 2016. The bulrush treatments were seeding (low and high density), planting seedling plugs, staking vegetation mats, and transplanting rhizome masses (**Figure 1**). The treatments were installed in 26 - 4m*16m strips in each of two wetland units at the Bear River Migratory Bird Refuge.

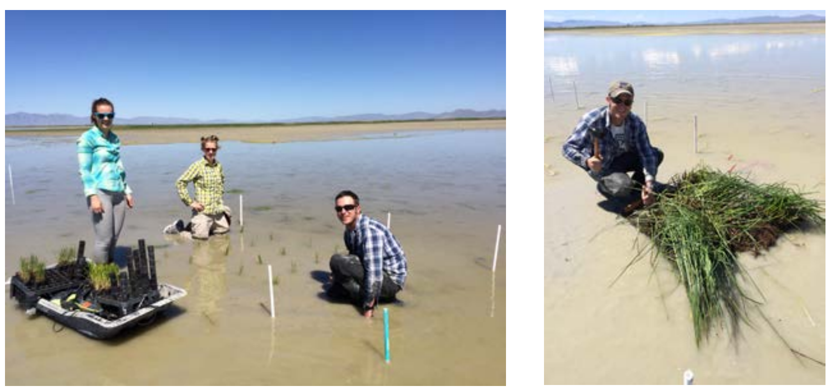

Figure 1. Planting seedling plugs in an experimental plot (at left; Rachel Hager, Karin Kettenring, David England) and installing sod mat (at right; David England).

Summary of findings

The plugs, mats, and rhizome transplants all had moderate establishment success (40-50% survival) after one month of installation, but by the end of the 2015 growing season almost all of the plants had completely died. Over the winter of 2015-2016, ice scouring disrupted the remaining plants. Despite the failure of these treatments, we were able to evaluate the logistics of implementation of these treatments for large-scale Great Salt Lake wetland restorations. The consensus among managers we communicated with was that these treatments are not logistically feasible to implement on any broad scale, especially given the high probability of failure.

Given much higher than predicted water levels, the seeded treatments lost almost all of their seeds and seedling emergence was negligible. Despite the failure of the seeding, we gained valuable insights into additional steps that need to be taken to ensure success for logistically-feasible, seed-based restoration for Great Salt Lake wetland plants. We have since spent significant time and effort evaluating the potential for a tackifier (adhesive substance mostly used in terrestrial restoration) for keeping seeds in place under moist or flooded conditions. Based on results from greenhouse experiments (David England M.S. thesis research), we are continuing to evaluate these treatments in field plots at Farmington Bay (Emily Martin Ph.D. dissertation research).

Objective 2: Identify individual genotypes of bulrushes that may limit *Phragmites* reinvasion.

Methods

We collected rhizome plant materials from throughout the Intermountain West (**Figure 2**). The rhizomes were planted in outdoor mesocosms and in the greenhouse on the USU campus in late spring / summer. As the rhizome material expanded over the summer and outgrew their containers, the rhizomes were divided into additional containers to continue the plant material increase. Baseline data on stem height, flowering density, and biomass were collected.

Summary of findings

We found that the different species, regardless of their source, allocated more energy either to stem height / density or number of flowers, but not both (**Figure 3**). There was also substantial variation among the source populations (**Figure 3**) over the growing season (**Figure 4**), and our next steps for this research will be to determine if when planted in assemblages of different source populations, the assemblages better "fill the space", due to their height and density variation among sources, to outcompete *Phragmites*.

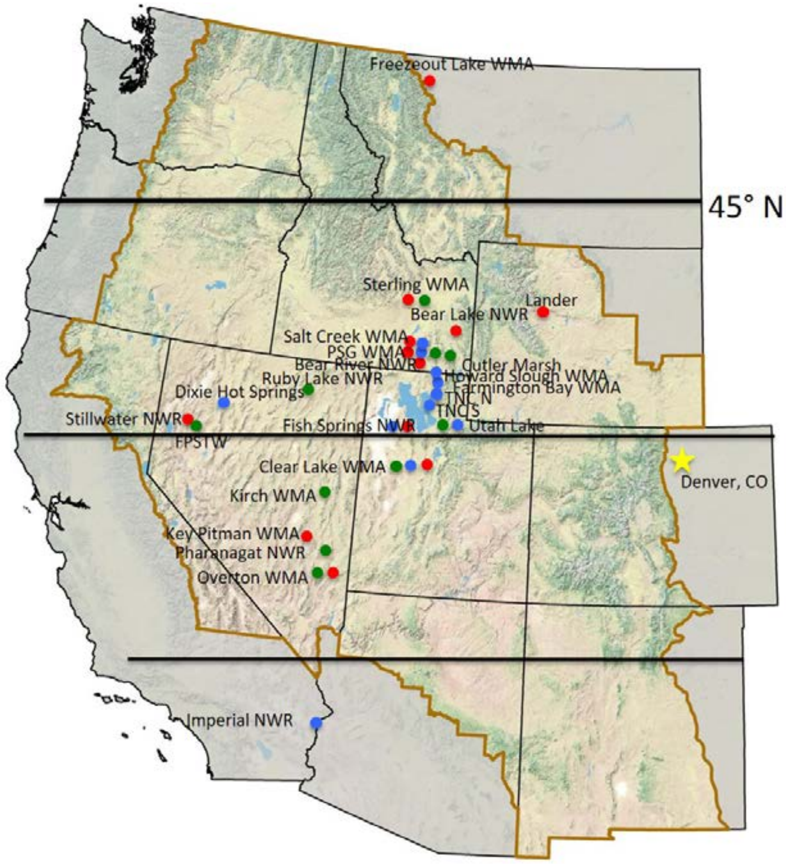

Figure 2. Map illustrating the location of rhizome collection sites. Red dots are *Bolboschoenus maritimus* (alkali bulrush), green dots are *Schoenoplectus acutus* (hardstem bulrush), and blue dots are *Schoenoplectus americanus* (threesquare bulrush).

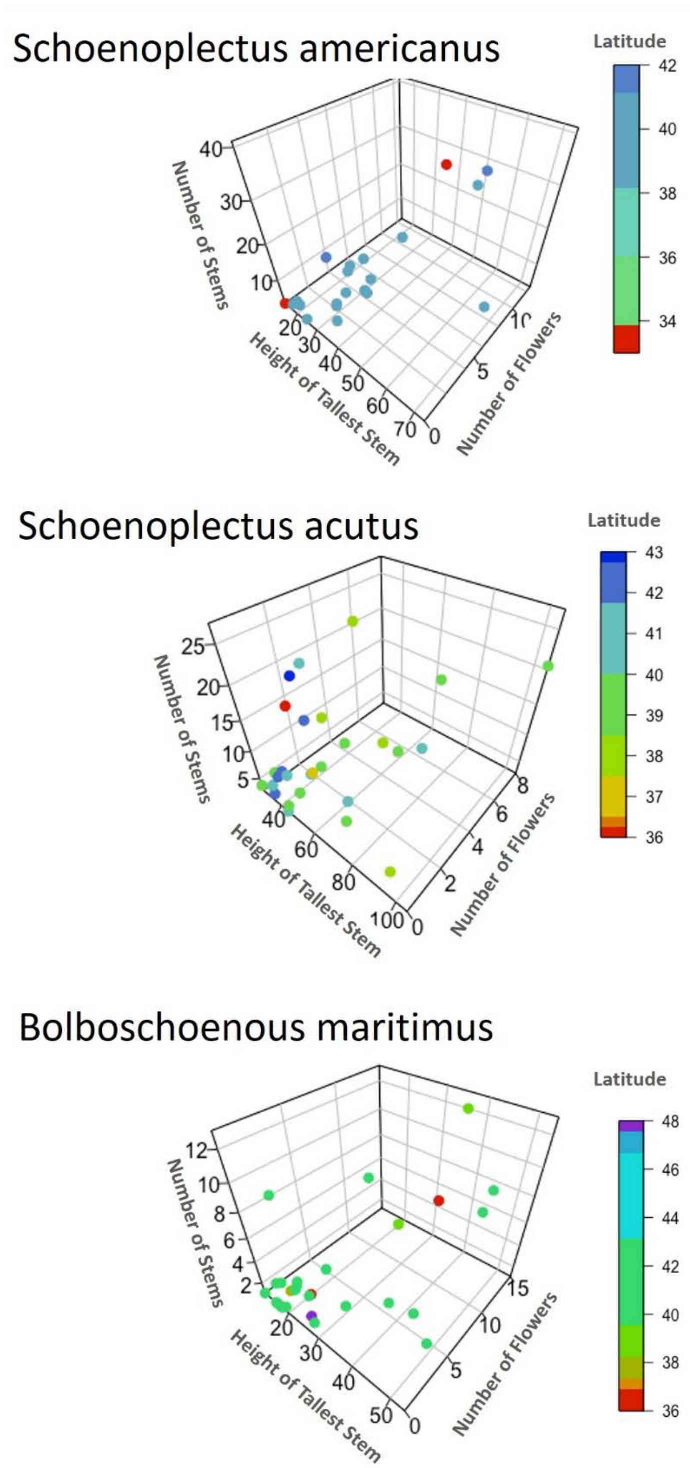

Figure 3. Variation in number of stems, height of tallest stem, and number of flowers for *Schoenoplectus americanus* (threesquare bulrush), *Schoenoplectus acutus* (hardstem bulrush), and *Bolboschoenus maritimus* (alkali bulrush) illustrated with a heat map based on source site latitude.

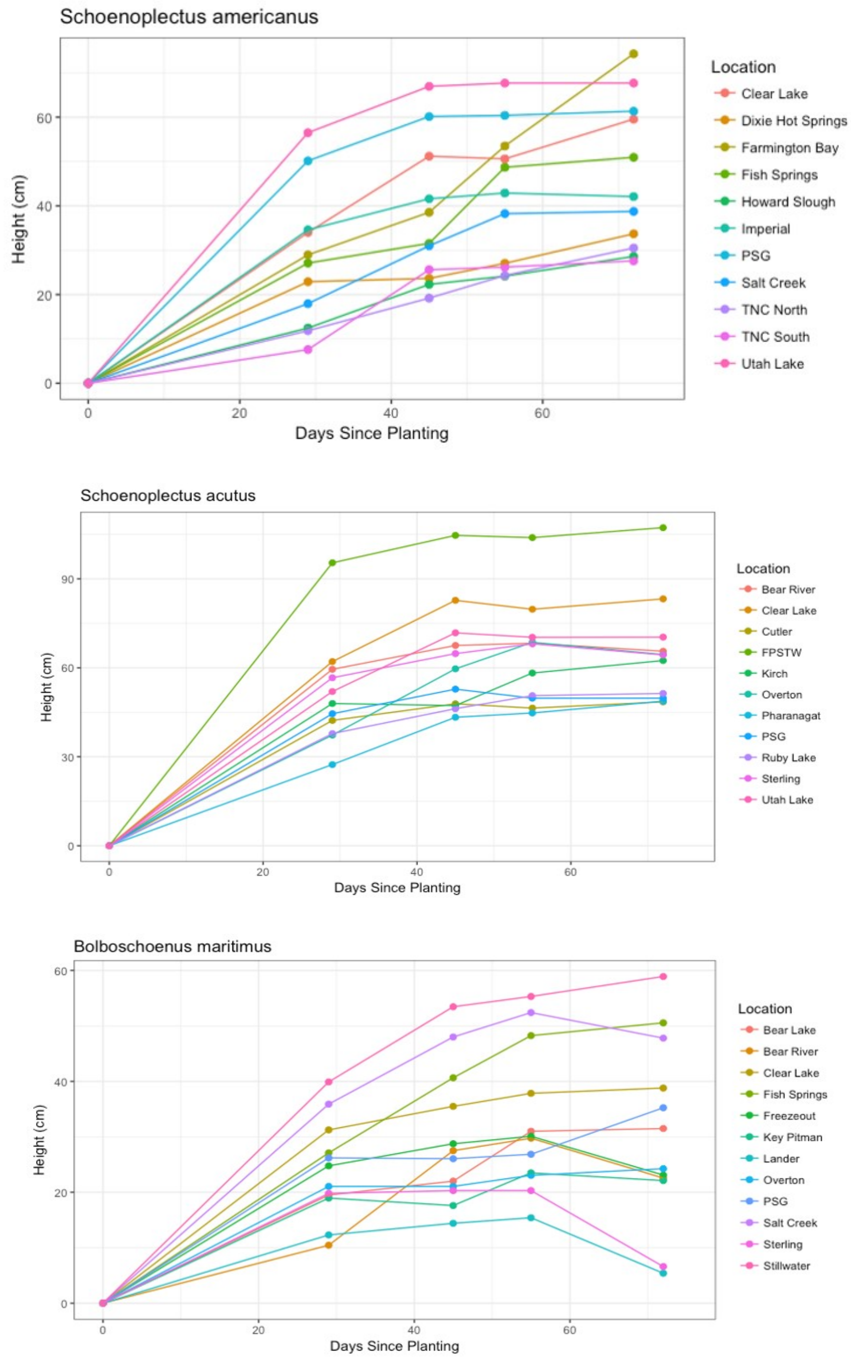

Figure 4. Height (cm) over the growing season of *Schoenoplectus americanus* (threesquare bulrush), *Schoenoplectus acutus* (hardstem bulrush), and *Bolboschoenus maritimus* (alkali bulrush) for twelve sites per species sourced from throughout the Intermountain West.

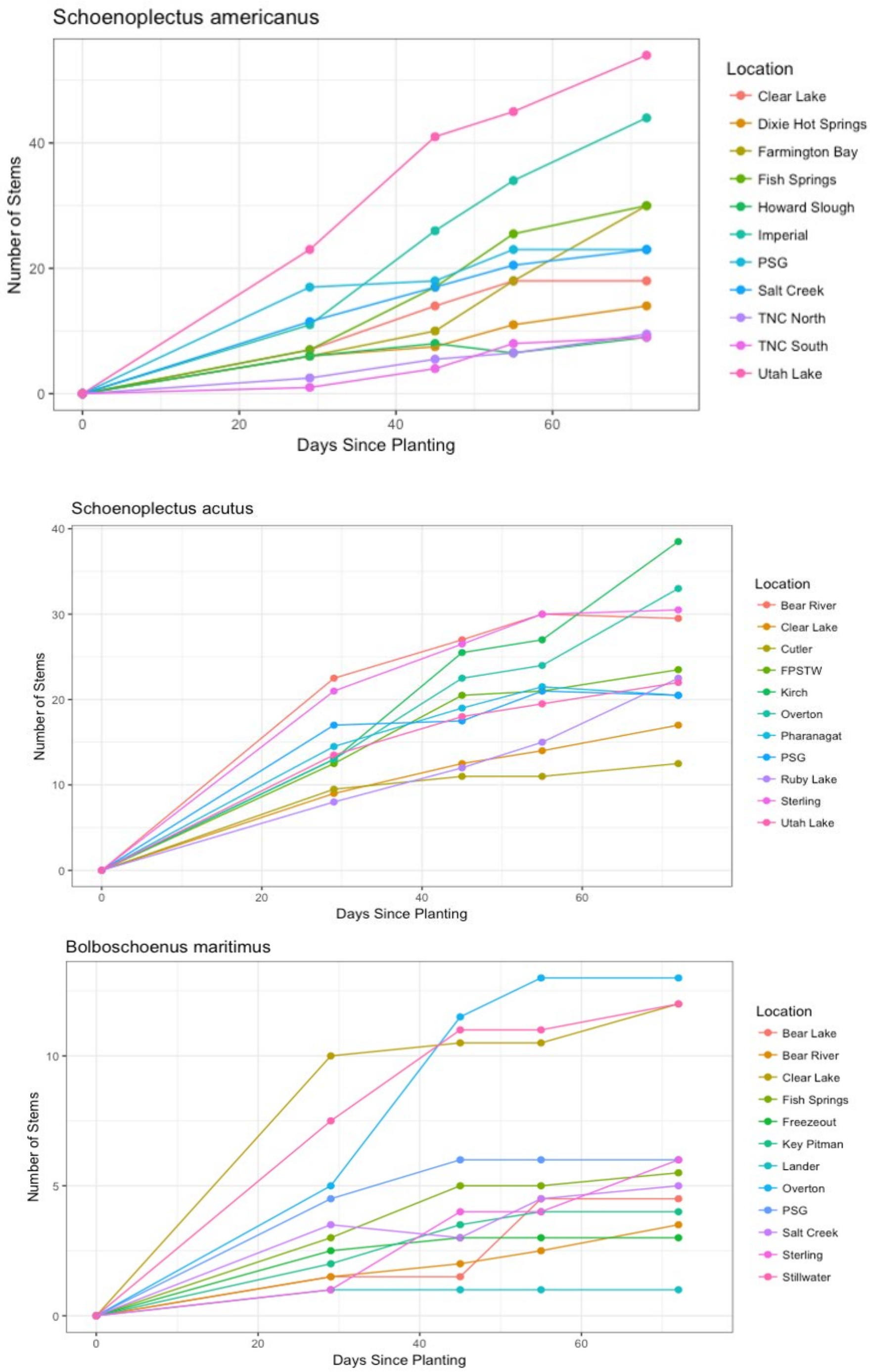

Figure 5. Stem density over the growing season of *Schoenoplectus americanus* (threesquare bulrush), *Schoenoplectus acutus* (hardstem bulrush), and *Bolboschoenus maritimus* (alkali bulrush) for twelve sites per species sourced from throughout the Intermountain West.

Objective 3: Identify competitive genotype assemblages of bulrushes that may limit *Phragmites* reinvasion

Methods

We conducted a mesocosm experiment where we evaluated the performance of *Phragmites* and native bulrushes when grown in competition. Each bulrush species (*S. acutus, B. maritimus*, *S. americanus*) was grown individually (no bulrush mixtures) and plants had either 1, 4, or 8 genotypes per plot (genetic diversity treatment; same rhizome density per plot). *Phragmites* seeds were also added to each mesocosm. Mesocosm were subjected to either low or high nutrient levels. At the conclusion of the experiment, after 15 weeks of growth, all the plants were harvested. We documented total stem count and number of flowering heads for both *Phragmites* and bulrush. Aboveground biomass was trimmed, the species separated, and dried in a drying oven (brand) at 80°C for 24 hours, then weighed.

Summary of findings

Surprisingly, genetic diversity did not have an influence on the ability of the bulrushes to compete against *Phragmites* (data not shown). In other words, we did not identify competitive genotype assemblages that performed well against *Phragmites*. However, because the genotypes we used for this experiment came from a relatively narrow geographic range, there may have been limited variation among the genotypes in their traits (e.g., height, density, biomass) that could allow them to compete well against *Phragmites*. We are going to repeat this experiment with genotypes collected from sites much further apart (that likely have greater variation in their traits between sites) such as those shown in Figure 2.

However, there were differences among the bulrush species in terms of which ones could best reduce *Phragmites* growth (**Figure 6** for height; data not shown for biomass). When comparing the *Phragmites*-only mesocosms to where it was grown with alkali bulrush, there was little change in *Phragmites* height (at low or high nutrients). However, threesquare bulrush reduced *Phragmites* height, especially under the low nutrient conditions. Hardstem bulrush reduced *Phragmites* height a little, under the low nutrient conditions only. These findings suggest the threesquare bulrush is the best of these three species for reducing *Phragmites* performance.

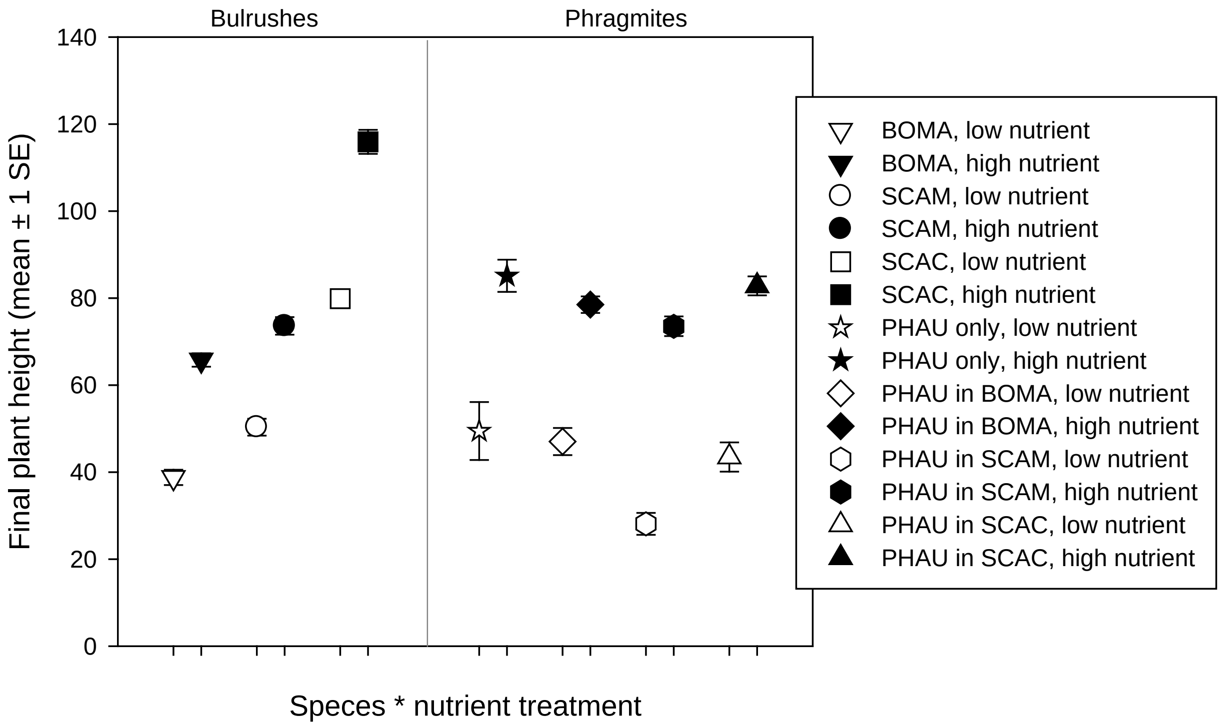

Figure 6. Plant height of the three bulrushes (left panel; BOMA = *B. maritimus* or alkali bulrush; SCAM = *S. americanus* or threesquare bulrush; SCAC = *S. acutus* or hardstem bulrush) and *Phragmites* (right panel; PHAU = *P. australis*) grown in mesocosms under high and low nutrient conditions. All bulrushes were grown in competition with *Phragmites*. However, for *Phragmites*, we had some *Phragmites*-only mesocosms ("PHAU only") and other instances where *Phragmites* was grown in competition with the bulrushes ("PHAU in BOMA", "PHAU in SCAM", "PHAU in SCAC").